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Impact of Decision Support Systems on Evaluating and Selecting Information System Projects (Case Study: National Iranian Gas Company)

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Abstract*: *The purpose of this research was to define and examine the various variables that affect Decision Support Systems (DSS) usage in evaluating and selecting information system (IS) projects and defined the most severe problems that could face decision-makers when they use DSS. The unit of analysis for this research was the senior experts, head of offices, deputies, and top, middle and lower level managers in National Iranian Gas Company headquarter staff. Questionnaire developed to generate a representative sample of items and achieve content validity. After the internal consistency examined, a multiple regression analysis undertook to examine the relationship between DSS usage in evaluating or selecting the IS projects as a dependent variable and affecting variables in DSS usage as independent variables. Results showed that the variables together explained 32.8 percent of DSS usage in evaluating and selecting of IS projects and just variable "Ease of use" having a significant impact on DSS usage.

Index Terms*: *Decision support systems, Information systems, IS projects evaluation, IS projects selection

I. INTRODUCTION

The rapid advance in information and communication technologies has effectively facilitated the development of IS projects [1], has been actively pursued by modern organizations in a globalized market to maintain their competitive advantages [2], reorganizing their business processes, and streamlining the provision of their products and services [1]. In fact in recent decades, information technologies (IT), including DSS, have transformed work and organizations [3]. Also, the process of evaluating and selecting IS projects in an organization is complex and challenging. The complexity of the selection process expected to the multidimensional nature of the decision process, the conflicting nature of the multiple selection criteria, availability of numerous IS projects [4], tangible and intangible benefits of the projects [5], and the presence of subjectiveness and imprecision. Subjectiveness and imprecision are always present in the human decision process due to insufficient information, abundant information, conflicting evidence, ambiguous information, and subjective information. The challenging of the selection process comes from the need for making transparent and rational decisions in a timely manner [6] and dynamic environment [4].

To ensure that the best possible IS project is selected with proper justification, it is advisable to use a structured approach to analyze the overall performance of available IS projects in decision setting. As a structured approach, DSS have been developed to solve various decision problems, included addressing the needs of multiple decision-makers or multiple criteria, modeling subjectiveness of the human decision making process, reducing cognitive demand of decision-makers [2] and difficulty in the process of selecting specific multicriteria analysis (MA) methods [4].

The application of DSS for solving the IS project evaluation and selection problem, however, is not a straightforward solution. This is due to the limitations of the existing DSS including the inadequacy in addressing both the characteristics of the problem and decision-maker requirements, the lack of decision-maker flexibility and to address a wide range of decision making situations, and the lack of capability to match the most appropriate MA method with the problem involved [4].

DSS is wide in number and characteristics, which makes it difficult to conduct large-scale investigation for decision-maker usage of DSS. The main core of this research was to determine the factors affecting the use of DSS in evaluating and selecting IS projects and influence of these factors in National Iranian Gas Company. Also, this paper defined the most severe problems that could face decision-makers when they use DSS.

II. LITERATURE REVIEW

Since the early 1970s, DSS technology and applications have evolved significantly. Many technological and organizational developments have exerted an impact on this evolution [7]. DSS have been developed to solve various decision problems. The application areas can be broadly divided into corporate functional management fields and other areas.

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Among these fields, the government appears to have the most DSS applications, followed by education, miscellaneous, natural resources, hospital and healthcare, military, urban/community planning and administration, and agriculture. Corporate functional, production and operations management contained the largest number of application articles published, followed by marketing, transportation, and logistics, management information systems, multifunctional systems, finance, strategic management, human resources, and inter-organizational decision support [8].

Much research has been devoted to the development and application of DSS for solving evaluation and selection IS project. Archer and Ghasemzadeh developed a DSS for solving the project portfolio selection problem. Test results strongly supported that users perceive project portfolio selection through a DSS as a useful and an easy to use tool for project portfolio selection [9]. Lin and Hsieh based on the concepts of DSS developed an integrated framework that incorporates fuzzy theory into strategic portfolio selection. The DSS reduced the decision-making time, and is a practical tool for dealing with the uncertainty problem of linguistic terms, the diversity of decision-makers' confidence levels, and the impact of the optimism level [10]. Mikhailov and Masizana explored the applicability of a new procedure to the decision process of IS project selection with a new fuzzy modification of the analytic hierarchy process (AHP) method [11]. Blackwell et al. presented the development process of an effective decision-support framework for adopting integrated information systems within small and medium enterprises (SMEs). The developed methodology helps to enabling companies to undertake a self-assessment process prior to making a decision on whether or not to integrate their IS [12]. Lee et al. performed an empirical investigation into the effect of users' DSS expertise on their problem-solving strategies. The results indicated that individuals who had only recently learned to use the DSS were confused or restricted by the set of functions provided by the system and did not plan well for their use of the DSS [13]. Deng and Wibowo presented a rule-based and intelligent DSS for facilitating the adoption of the most appropriate MA method in solving IS project evaluation and selection problems. The proposed DSS framework has a number of advantages include the flexibility to respond quickly to the decision-maker's questions, the ability to improve the decision-maker better understand the decision problem and the implications of their decision behaviors, and the capability to accommodate various requirements of the decision problem and the decision-maker [4, 14]. Also, they presented a DSS for effectively solving of the IS project selection problem. The proposed DSS recognize the multidimensional nature of the IS project, the availability of MA methods, and the preferences of the decision-maker [15]. Yeh et al. presented a fuzzy multicriteria group decision making approach for evaluating and selecting IS projects [2], [6]. Oztekin proposed a DSS for usability assessment and design of web-based information systems (WIS). The results showed that the DSS supports the determination of critical usability problems and hence definition of relevant improvement strategies [16].

III. ADAPTING AND EXTENDING THE TECHNOLOGY ACCEPTANCE MODEL

The constructs composing the research model were operationalized using a combination of items extracted from previous relevant research and newly composed items.

A. DSS usage

The extent to which decision-makers use information systems or engage in other computer-related activities is most economically determined by asking them directly [17]. Three dimensions of DSS usage were derived from self-reported estimates of percentage use of the DSS in evaluating and selecting IS projects, level or depth of use and frequency of use.

B. Ease of use and usefulness

It posits that individuals' behavioral intention to use an IT is determined by two beliefs: "perceived usefulness"', defined as the extent to which a person believes that using an IT will enhance his or her job performance, and "perceived ease of use", defined as the degree to which a person believes that using an IT will be free of effort [18]. Each of "Ease of use" and "Usefulness" indicates with 6 statements.

C. Task characteristics

Increasingly complex decisions require significant expertise, insight and intuition, and may be made more effectively using information systems. Complexity means existence of multiple and conflicting interpretations of the problem definition, which is particularly problematic for the decision maker in using DSS [19]. To operationalize the concept of task characteristics the researcher combined both the complexity of the task of selecting IS projects and the different stages of this process.

D. Cultural characteristics

Cultural factors are increasingly cited as significant influences on IT adoption [20], [21]. This construct investigates how the psychological context on both the individual and organizational level affects the perception and use of DSS in evaluating and selecting IS projects [22].

E. DSS characteristics

The technical quality of the DSS may influence DSS usage. Indeed, it is clear that the quality and accessibility of the information provided by the DSS is crucial. Low technical quality, whether real or imagined may influence DSS usage. Previous studies have found that certain DSS characteristics seem to have a significant influence on the effectiveness of the systems: user-friendliness; ease of use; size (cost) of DSS; range of alternatives; timeliness, accuracy and relevancy of output [17].

F. Environmental characteristics

Based on previous literature, the instrument asked the respondents to indicate their agreement or disagreement with 4 statements reflecting the different environmental characteristics that might affect DSS usage, included competition among provinces, favorable government policies,

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uncertainty in the government environment and favorable market conditions.

G. Organizational characteristics

Many studies have investigated the effect of organizational attributes on the effectiveness of information systems in general and DSS in particular [23], [24], [25]. Based on previous literature, the instrument asked the respondents to indicate their agreement or disagreement with 7 statements reflecting the different organizational characteristics that might affect DSS usage.

H. Internal support characteristics

Internal support given to decision makers within the organization either through training within the organization or other sources of support may be a significant impact on DSS usage. Elbeltagi et al suggest that internal support including the availability of skilled DSS staff, training opportunities and a network of supportive colleagues would be a significant influence on the executive perception of the usefulness of the DSS and its ease of use and thus it might affect the level of DSS usage [17].

I. External support characteristics

Good vendors may act as surrogate IT departments, providing business-specific advice and technical support. The instrument asked the respondents to indicate their agreement or disagreement with 3 statements reflecting the different external support characteristics that might affect DSS usage.

J. Decision-maker characteristics

The importance of decision-maker characteristics as determinants of information systems success has been emphasized by several authors [23], [26], [27]. Decision-makers characteristics were measured by asking mangers to indicate their agreement or disagreement with 12 statements reflecting the mentioned different dimensions of decision-makers characteristics in DSS usage.

K. Top management support characteristics

It is essential that top management participation be active, and not merely symbolic [17]. Top management support and training have mainly been recognized as critical success factors. Their beneficial effects are not always borne out in empirical data [28]. Top management support indicates with 6 statements of top management support in DSS usage.

IV. METHODOLOGY

The study of DSS can be restricted into three broad areas: theory, application, and contributing disciplines [29]. Research theme used for the study of DSS can be classified into three general categorizes: (1) Design refers to the concepts and methods utilized for the development and implementation of DSS. (2) Effects of use refer to the examination of the consequences of utilizing and the value derived from using a DSS. (3) Technology focuses on the tools used to build and/or use a system [30]. A major omission in DSS scholarship is the poor identification of clients and users of the various DSS applications that are the focus of investigation. Arnott and Pervan Suggestion strategy for improving the relevance of DSS research is to increase the number of case studies [31].

The present study is an applied research in terms of its objectives. It is causative in terms of the method of study and is considered a descriptive-survey in terms of the nature and method of dealing with the research questions. In addition, it is based on an empirical investigation of National Iranian Gas Company. Library resource, articles, and professional books used to prepare the theory basis and research literature. Meanwhile, a questionnaire designed based on Elbeltagi's questionnaire [22] for obtaining field data. The unit of analysis for this research is the senior experts, head of offices, deputies, and top, middle and lower level managers in National Iranian Gas Company headquarter staff.

To generate a representative sample of items and to achieve content validity, questionnaire development followed several steps. The first activity involved the examination of the DSS literature to ascertain different characteristics and activities of DSS noted by previous researchers. The second process consisted of interviews with IT managers and decision-makers in National Iranian Gas Company. Respondents were asked to comment on any aspect of DSS usage in decision-making in their jobs. Finally, to ensure content validity, several exporters reviewed the questionnaire and provided input for revision.

To determine the reliability for the purpose of this study, Cronbach's alpha was computed for each construct. While increasing the value of alpha is partially dependent upon the number of items in the scale, it should be noted that this has diminishing returns. For conduct data analysis using individual items is particularly troubling because single item reliabilities are generally extremely low, and without reliable items the validity of the item is poor at best and at worst unknown [32]. So Cronbach coefficient alpha was used to determine the reliability of all multi-items scales. All scales showed acceptable reliability (0.7) [33] as indicated in the following table (Table 1).

Table 1: Cronbach's coefficient alpha for construct

Factors	α
DSS usage (3 items)	0.827
Ease of use (6 items)	0.758
Usefulness (6 items)	0.909
Task characteristics (5 items)	0.740
Cultural characteristics (4 items)	0.753
DSS characteristics (12 items)	0.739
Environmental characteristics (4 items)	0.805
Organizational characteristics (7 items)	0.837
Internal support characteristics (4 items)	0.841
External support characteristics (3 items)	0.885
Decision-maker characteristic (12 items)	0.889
Top management characteristics (6 items)	0.901

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Table 2: Multiple regression analysis between variables affecting DSS usage (independent variables) and DSS usage (dependent variable)

Variables affecting DSS usage	Mean	Coefficient	*t*-statistic	Sig. *T*
Ease of use	3.149	0.404	3.033	0.004
Usefulness	3.662	-0.080	-0.424	0.666
Task characteristics	3.330	0.014	0.073	0.942
Cultural characteristics	3.248	-0.120	-0.834	0.409
DSS characteristics	3.177	0.273	1.654	0.105
Environmental characteristics	3.086	-0.118	-0.755	0.454
Organizational characteristics	3.541	-0.165	-0.728	0.470
Internal support characteristics	3.183	-0.066	-0.394	0.695
External support characteristics	3.525	-0.328	-1.546	0.129
Decision-maker characteristic	3.644	0.154	0.638	0.526
Top management characteristics	3.627	0.388	1.866	0.68
Notes: $R^2 = 0.328$; $n = 60$				

Previously validated scales were used for all of the constructs in this study. Respondents were asked to indicate the variables affecting DSS usage on a five-point bipolar scale with scale poles ranging from strongly disagree – 1 to strongly agree – 5. Also, they were asked to indicate problems of DSS usage on a five-point bipolar scale (1 – not a problem, 5 – an extreme problem).

After the pilot test, the questionnaire was sent to a purposeful sample of 200 person who were a priori identified as DSS users, yielding 60 useable questionnaires being returned accounting for an effective response rate of 30 percent and considered to be adequate [34].

In fact, this research tries to deal with questions:

- Which variables affecting DSS usage in evaluating and selecting of IS projects?
- What are the problems related to DSS usage in evaluating and selecting of IS projects?

V. DATA ANALYSIS

Prior to analyzing the data a description of the sample is provided. As far as the age of the company was concerned, the mean of the company were 40.04 years old with 9.82 standard deviation. This indicates that the company had significant experience and was most capable of judging the main DSS features.

After examining the internal consistency, a multiple regression analysis was conducted to examine "Which variables affecting DSS usage in evaluating and selecting of IS projects?" A multiple regression analysis was undertaken to examine the relationship between DSS usage in evaluating and selecting of IS projects as a dependent variable and the 11 variables as independent variables (Table 2). Because of sample size limitations, multi-item constructs for the external variables were measured using a summated scale derived as the average value of all items pertaining to these construct [35].

The analysis resulted in an R2 = 0.328 suggesting that the 11 variables together explained 32.8 percent of DSS usage in evaluating and selecting of IS projects. The results also show only one variable "Ease of use" (t-value = 3.033, $p < 0.01$) as having a significant impact on DSS usage. Overall, the results indicate that the DSS usage in evaluating and selecting of IS projects was positively influenced by ease of use.

For examining "What are the problems related to DSS usage in evaluating and selecting of IS projects?" Thirty-eight problems were used to assess their relative severity as perceived. Firstly, problems were identified as being equally critical with mean scores greater than three on a five-point scale. Then problems are ranked according to their "severity score": that is, the percentage of respondents who rated them as either a serious problem or an extreme problem (i. e., 4 or 5 on a 5-point scale). The resulting ranking, as shown in table 3.

VI. DISCUSSION

This study integrated the theoretical approaches and empirical findings of research on DSS usage in National Iranian Gas Company. Multiple regression analysis was undertaken to examine the relationship between DSS usage in evaluating and selecting of IS projects as a dependent variable and 11 variables as independent variables.

The unit of analysis for this research is the senior experts, head of offices, deputies, and top, middle and lower level managers in National Iranian Gas Company headquarter staff. Respondents were aged 25 to 62 and had an average of 13.6 years of experience in the company and 4.2 years in their current positions. Some 96% had university qualifications. The results showed that the percentage of DSS usage in National Iranian Gas Company was 51.8% which means this kind of technology has been used above 50%.

The results showed only one variable "Ease of use" (t-value = 3.033, $p < 0.01$) as having a significant impact on DSS usage,

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which may indicate that decision-maker managers in evaluating and selecting of IS projects use DSS technology primarily on the basic of ease of use.

which remains, as one of the most fundamental underlying causes behind the so called "productivity paradox", the study identified the most severe problems that the decision-makers

Table 3: Severity of the problems of DSS usage in evaluating and selecting of IS projects

Rank	Problem	Score %	Mean
1	Lack of experience to be able to use DSS in evaluating and selecting of IS projects	55.17	3.28
2	Absence of appropriate training for DSS staff	50.00	3.36
3	The available DSS software does not actively participate in my decisions	50.00	3.26
4	Unreasonable expectations attributed to DSS as a solution for all organizational problems	48.27	3.36
5	I did not get involved in the development of the DSS software that I use	47.37	3.39
6	Lack of an external consultant support for DSS implementation and use.	47.27	3.24
7	Absence of appropriate training for decision- makers to use DSS	46.55	3.31
8	Lack of timeliness of information or data	42.37	3.20
9	Lack of appropriate planning for adopting DSS	42.10	3.28
10	Lack of strategic vision for decision-makers	41.82	3.04
11	When it is necessary to compare or aggregate data/information from two or more different sources, there may be unexpected or difficult inconsistencies	40.68	3.20
12	Difficulty in modeling and simulating the decisions by DSS usage	37.93	3.09
13	Qualitative information which is important in making decisions is not available in the DSS software that I use	37.73	3.06
14	Failure to assess DSS effectiveness in the early stages of implementation	37.29	3.02
15	Lack of expertise in DSS in the organization	36.20	3.12
16	Incompleteness of information or data	36.20	3.12
17	Difficulty of changing the legacy of making strategic decisions because of rigid regulations	35.59	3.03
18	Lack of internal support for DSS implementation and use	34.48	3.02
19	Difficulty in finding DSS staff who have the required skills and knowledge	33.90	3.05
20	Irrelevant information or data for the different decisions I usually make	31.58	3.00
21	Difficulty in financially justifying benefits of DSS usage	31.03	3.02
22	Lack of senior management leadership for DSS efforts	28.81	3.02

The resulting problems ranking, indicates that 55.17% of the respondents considered “lack of experience to be able to use DSS in evaluating and selecting of IS projects” a principal or an extreme problem, putting this at the top of the list in terms of severity. The following principal serious problems were secondary (50.00%), “absence of appropriate training for DSS staff”; third (50.00%), “the available DSS software does not actively participate in my decisions”; fourth (48.27%), “unreasonable expectations attributed to DSS as a solution for all organizational problems”; fifth (47.37%), “lack of an external consultant support for DSS implementation and use.”

VII. CONCLUSION

The aim of this research was to define and examine the various variables that affect DSS usage in evaluating and selecting IS projects and to define the most severe problems that could face decision-makers when they use DSS. Variables included ease of use, usefulness and also the characteristics of the following variables, task, cultural, DSS, environmental, organizational, internal support, external support, decision-maker, and finally top management. Additionally to solve the problem of underutilized systems, encounter when they use DSS in National Iranian Gas Company. Results showed that just variable “ease of use” having a significant influence on DSS usage and a principal or an extreme problem was “lack of experience to be able to use DSS in evaluating and selecting of IS projects”.

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